PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number:
H04B 7/26, H04Q 7/04	A1	WO 93/20625
		(43) International Publication Date: 14 October 1993 (14.10.93)

(21) International Application Number: PCT/SE93/00238

(22) International Filing Date: 22 March 1993 (22.03.93)

(30) Priority data:
9200962-0 27 March 1992 (27.03.92) SE

(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON [SE/SE]; S-126 25 Stockholm (SE).

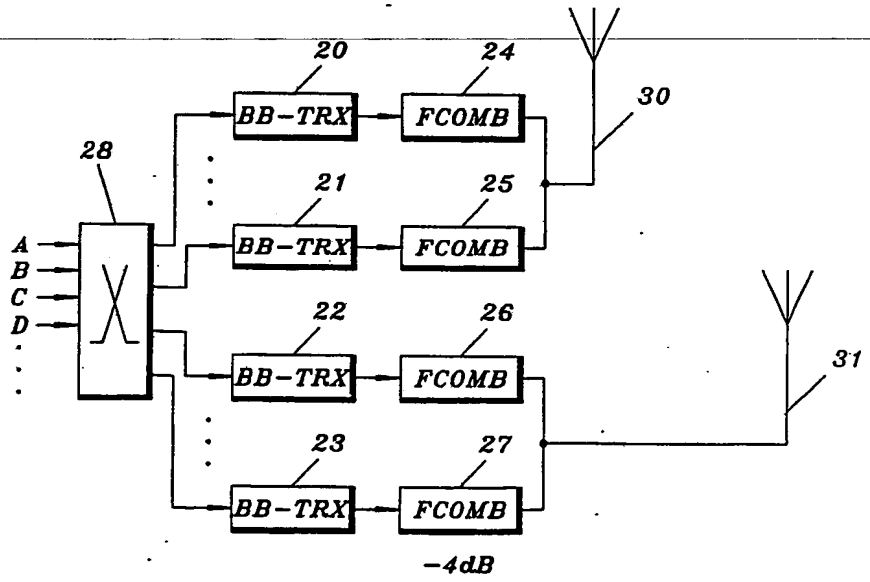
(72) Inventor: BORG, Lars, Uno ; Stickelbärsvägen 4, S-114 23 Stockholm (SE).

(74) Agents: BJELLMAN, Lennart et al.; Dr Ludwig Brann Patentbyrå AB, Box 1344, S-751 43 Uppsala (SE).

(81) Designated States: AU, BR, CA, FI, JP, KR, NZ, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: A BASE STATION FOR A FREQUENCY HOPPING TDMA RADIO COMMUNICATION SYSTEM



(57) Abstract

A base station for a cellular frequency hopping TDMA radio communication system comprises at least two transmitter groups, each containing at least one transmitter (20, 21 and 22, 23), connected to individual antennas (30; 31) in an antenna group of a cell. Furthermore, means (28) are included for controlled frequency hopping in at least one TDMA channel such that its signal bursts are distributed on different antennas (30; 31) in the antenna group.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NL	Netherlands
BE	Belgium	GN	Guinea	NO	Norway
BF	Burkina Faso	GR	Greece	NZ	New Zealand
BG	Bulgaria	HU	Hungary	PL	Poland
BJ	Benin	IE	Ireland	PT	Portugal
BR	Brazil	IT	Italy	RO	Romania
CA	Canada	JP	Japan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo			SE	Sweden
CH	Switzerland	KR	Republic of Korea	SK	Slovak Republic
CI	Côte d'Ivoire	KZ	Kazakhstan	SN	Senegal
CM	Cameroon	LI	Liechtenstein	SU	Soviet Union
CS	Czechoslovakia	LK	Sri Lanka	TD	Chad
CZ	Czech Republic	LU	Luxembourg	TG	Togo
DE	Germany	MC	Monaco	UA	Ukraine
DK	Denmark	MG	Madagascar	US	United States of America
ES	Spain	ML	Mali	VN	Viet Nam
FI	Finland	MN	Mongolia		

A BASE STATION FOR A FREQUENCY HOPPING TDMA RADIO COMMUNICATION SYSTEM

TECHNICAL FIELD

The present invention relates to a base station for cellular frequency hopping TDMA radio communication systems.

BACKGROUND OF THE INVENTION

Base stations in cellular frequency hopping TDMA communication systems often comprise frequency hopping transmitters and broad band combiners, in which case the frequency hops are performed in the transmitter itself, or transmitters capable of sending on only a single frequency and filter combiners, in which case the frequency hops are performed by switching the signal to different transmitters, so called base band hops. A disadvantage of these systems is the power loss that is associated with each combiner stage, approximately 3 dB for broad band combiners and approximately 4 dB for filter combiners. Since especially broad band combiners usually accept only two input signals the accumulated loss in several combiner stages in a base station can be unacceptable if the number of transmitters exceeds approximately 4.

SUMMARY OF THE INVENTION

Thus, an object of the present invention is to provide a base station for frequency hopping TDMA radio communication systems, in which the transmitter output power is better utilized and which furthermore provides transmission with space diversity.

The above object is in accordance with the present invention solved by a base station that is characterized by at least two transmitter groups, each containing at least one transmitter, connected to individual antennas in an antenna group of a cell, and by means for controlled frequency hops in at least one TDMA channel such that its signal bursts are distributed on different

antennas within the antenna group.

From U.S. patent specification 4 545 059 it is known per se to connect two antennas to a frequency hopping transmitter. However, in the known apparatus both antennas are simultaneously connected to the same output signal.

Furthermore, from European patent application 91 850022.4 it is previously known to order an antenna change in a base station from a mobile station in case the reception is poor. However, in this previously known apparatus a switch is not provided until after the transmitter section, which means that no gain in power is possible.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may best be understood by making reference to the following description taken together with the accompanying drawings, in which:

FIGURE 1 diagrammatically shows a previously known structure for a base station in a TDMA mobile radio communication system;

FIGURE 2 diagrammatically shows another previously known structure for a base station in a TDMA mobile radio communication system;

FIGURE 3 diagrammatically shows an embodiment of the present invention based on the structure in Figure 1; and

FIGURE 4 diagrammatically shows another embodiment of the present invention based on the structure of Figure 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout the Figures of the drawing the same reference designations have been used for corresponding elements.

Figure 1 diagrammatically shows a previously known structure for a base station in a TDMA mobile radio communication system. In this structure four signals A-D are directed to corresponding transmitters SY-TRX 10-13. These transmitters can perform the frequency hops themselves. Such a transmitter is often called "synthesizer hopping transmitter". The output signals from each pair of transmitters 10, 11 and 12, 13, respectively, are directed to corresponding broad band combiners HCOMB 13 and 15. Such combiners are often referred to as hybrid combiners. The output signals from these hybrid combiners 14, 15 are directed to a further hybrid combiner 16, the output signal of which is directed to an antenna 17. In each combiner stage about 3 dB of the output power is lost (half of the power). If more transmitters are desirable, e.g. if the call capacity is to be increased, the number of combiner stages has to be increased, since hybrid combiners only can have two inputs. Thus, this structure is most suitable for base stations with a low call capacity.

Figure 2 diagrammatically shows another previously known structure for a base station in a TDMA mobile radio communication system. In this structure signals A-D are directed to a number of transmitters BB-TRX 20-23 over a switch 28. These transmitters are capable of transmitting on only a single frequency. Such transmitters are often referred to as "base band hopping transmitters". The reason for this is that the frequency hops in this case are not performed in the transmitter but in switch 28, which switches different signal bursts or time slots of signals A-D to different transmitters 20-23. Signal A can for instance during one time slot be connected to transmitter 20, during the next time slot to transmitter 22, then to transmitter 21, etc. The output signals from transmitters 20, 21 are directed to associated filter combiners 24, 25, while the output signals of

transmitters 22, 23 are directed to associated filter combiners 26, 27. The output signals from filter combiners 24, 25 are combined and directed to one input of a hybrid combiner 16. In the same way the output signals from combiners 26, 27 are directed to the other input of hybrid combiner 16. The output of hybrid combiner 16 is connected to an antenna 17.

In figure 2 only four input signals A-D and four transmitters 20-23 have been shown. However, the dots indicate that this structure usually contains more input signals and more transmitters. A transmitter group, e.g. the group containing transmitters 20, 21, can comprise e.g. up to 16 transmitters.

Also in this structure there is a power loss in two stages, namely approximately 4 dB in the filter combiner stage and approximately 3 dB in the hybrid combiner stage.

Figure 3 diagrammatically shows an embodiment of the present invention based on the structure of Figure 1. In this embodiment the hybrid combiner 16 closest to the antenna 17 in Figure 1 has been eliminated. Instead the output signal from hybrid combiner 14 is directly fed to the antenna 30, while the output signal from hybrid combiner 15 is directly fed to an antenna 31. This division is possible due to the fact that the TDMA transmission schedule for a cell guarantees that two transmitters do not simultaneously transmit on the same frequency.

If the base station contains more transmitters and therefore also more combiner stages the method could be repeated, so that the combiner closest to the antenna is eliminated and replaced by two antennas. For each combiner stage that is eliminated there is a doubling of the number of antennas. For each combiner stage eliminated one also obtains a power gain of approximately 3 dB.

The obtained power gain can be used either for an increase of the output power or for an increase of the number of transmitters without changing the output power.

Furthermore, if antennas 30, 31 are located at a sufficiently large distance from each other, i.a. a number of wavelengths, e.g. a distance of the order of 3 m or more for carrier frequencies of approximately 900 MHz, it is also possible to obtain space or antenna diversity. This is obtained by connecting a switch 28 before the transmitters 10-13 and alternately switching the signals between transmitter groups 10, 11 and 12, 13, respectively. Hereby the signal bursts of a TDMA channel will not only change frequency but also transmitter antenna.

If more than two antennas are used the signal bursts can e.g. cyclically be switched between the antennas in the antenna group.

In another embodiment the signal bursts can randomly be switched between the antennas in the antenna group.

In a further embodiment the switching can be performed on demand, e.g. when a mobile station has detected that the signal from an antenna is unacceptable and orders change of antenna within the antenna group. The signalling can e.g. be performed in the same way as is described in European patent application 91 850022.4.

One reason that the described antenna diversity is so efficient is that the bit interleaving that usually is used in digital radio communication systems. In e.g. the US standard IS-54 for digital mobile telephony the bits in a 20 ms speech frame are bit interleaved over two consecutive time slots in a traffic channel. In the European GSM system the bits in a speech frame are interleaved over eight time slots. However, in both cases half the number of signal bursts will be transmitted on one antenna and the remaining signal bursts will be transmitted on the other antenna. Hereby it is avoided that all the bits in a speech frame are received by the mobile station on a rapidly fading channel. Due to the redundancy of the coding the speech frames can be reconstructed from the correctly received bits.

Figure 4 diagrammatically shows another embodiment of the present

invention based on the structure of Figure 2. Also in this embodiment the hybrid combiner 16 has been eliminated and the combined signal from filter combiners 24, 25 are fed to an antenna 30 and the signals from filter combiners 26, 27 to an antenna 31.

Thus, a power gain of 3 dB has been obtained also in the embodiment of Figure 4. This power gain can be used for an increase of the output power from the base station. As an alternative the number of transmitter groups can be increased with a further hybrid combiner stage without increasing the power loss as compared to the case in which only one antenna is used.

The embodiment of Figure 4 has the further advantage that the antenna diversity is easily obtained since switch 28 is already present in the structure.

Another advantage of the space diversity obtained by the invention is the increased flexibility in the planning of the TDMA-transmitting schedule. Since diversity, namely space diversity, is obtained already by the antenna change between two time slots, it is e.g. possible to refrain from frequency hops between these time slots or to reduce the number of hopping frequencies. A reduction of the number of hopping frequencies can be of special interest in connection with base stations that are equipped with transmitters that are sending only on a single frequency, since in this case the number of hopping frequencies is limited to the number of transmitters.

It will be understood by those skilled in the art that various modifications and changes may be made to the present invention without departure from the spirit and scope thereof, which is defined by the appended claims.

CLAIMS

1. A base station for cellular frequency hopping TDMA radio communication systems, **characterized by**

at least two transmitter groups, each containing at least one transmitter (10, 11 and 12, 13; 20, 21 and 22, 23), each connected to an antenna (30; 31) in an antenna group of a cell, and

means (28) for controlled frequency hops in at least one TDMA channel, such that the signal bursts thereof are distributed on different antennas (30, 31) within the antenna group.

2. The base station of claim 1, **characterized in that** all antennas in the antenna group are always sending on the different frequencies.

3. The base station of claim 2, **characterized in that** the distance between antennas in the antenna group exceeds more than a few carrier wavelengths.

4. The base station of claim 3, **characterized by** means (28) for cyclic distribution of the signal bursts on antennas (30; 31) within the antenna group.

5. The base station of claim 3, **characterized by** means (28) for randomly distributing the signal bursts on the antennas (30; 31) within the antenna group.

6. The base station of claim 3, **characterized by** means (28) for demand controlled distribution of the signal bursts on the antennas (30; 31) within the antenna group.

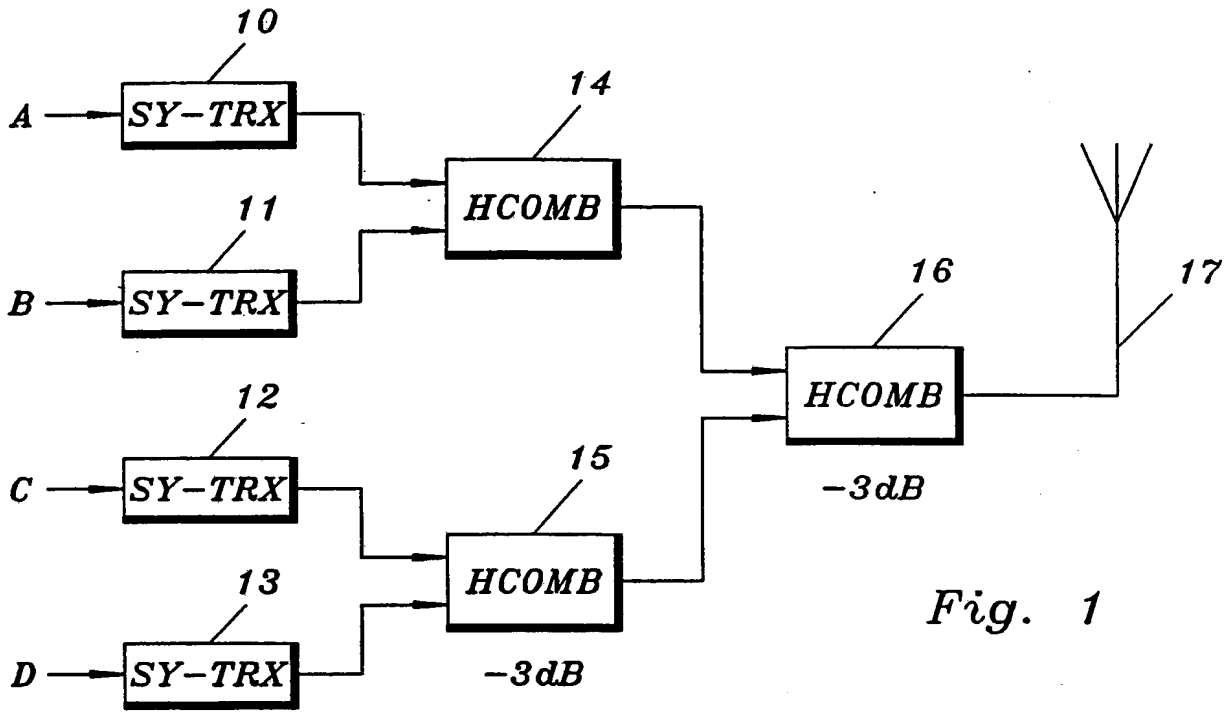

10
A
SY-TRX
14
HCOMB
11
B
SY-TRX
16
17
HCOMB
12
C
SY-TRX
15
HCOMB
-3dB
13
D
SY-TRX
-3dB

Fig. 1

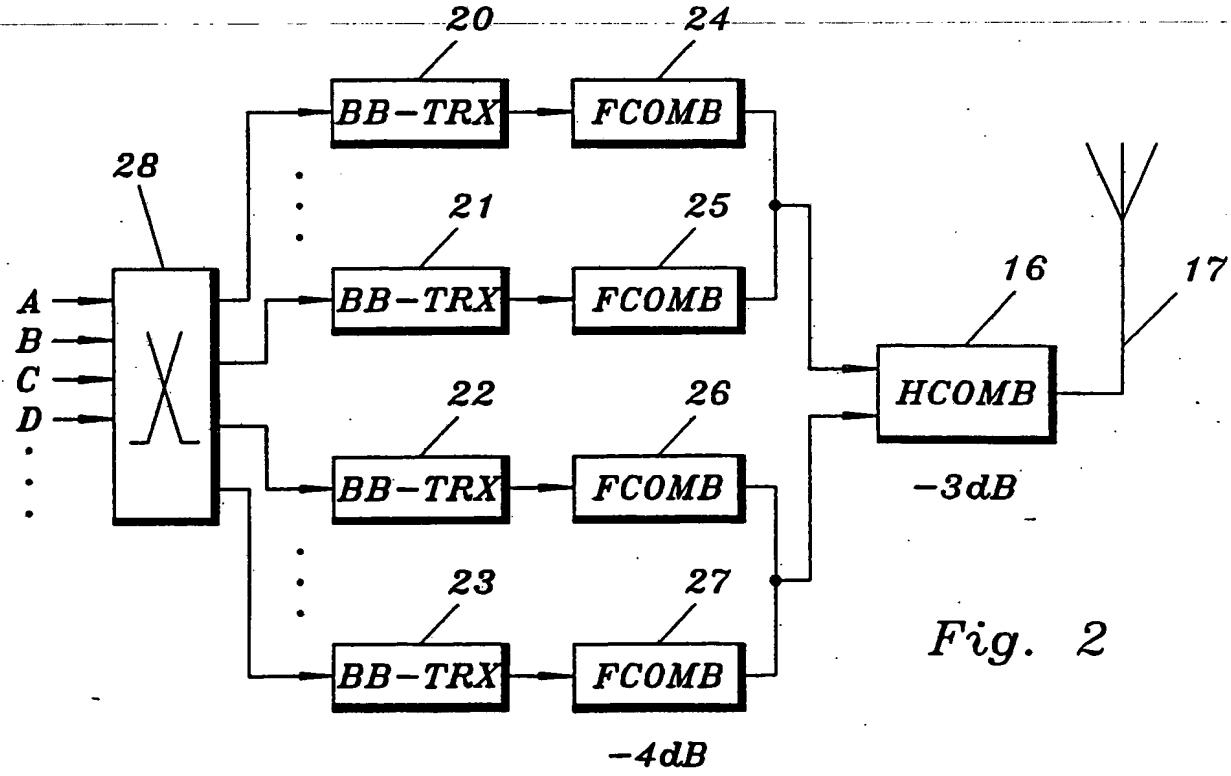

20
24
BB-TRX
FCOMB
28
21
25
A
B
C
D
BB-TRX
FCOMB
16
17
HCOMB
22
26
BB-TRX
FCOMB
-3dB
23
27
BB-TRX
FCOMB
-4dB

Fig. 2

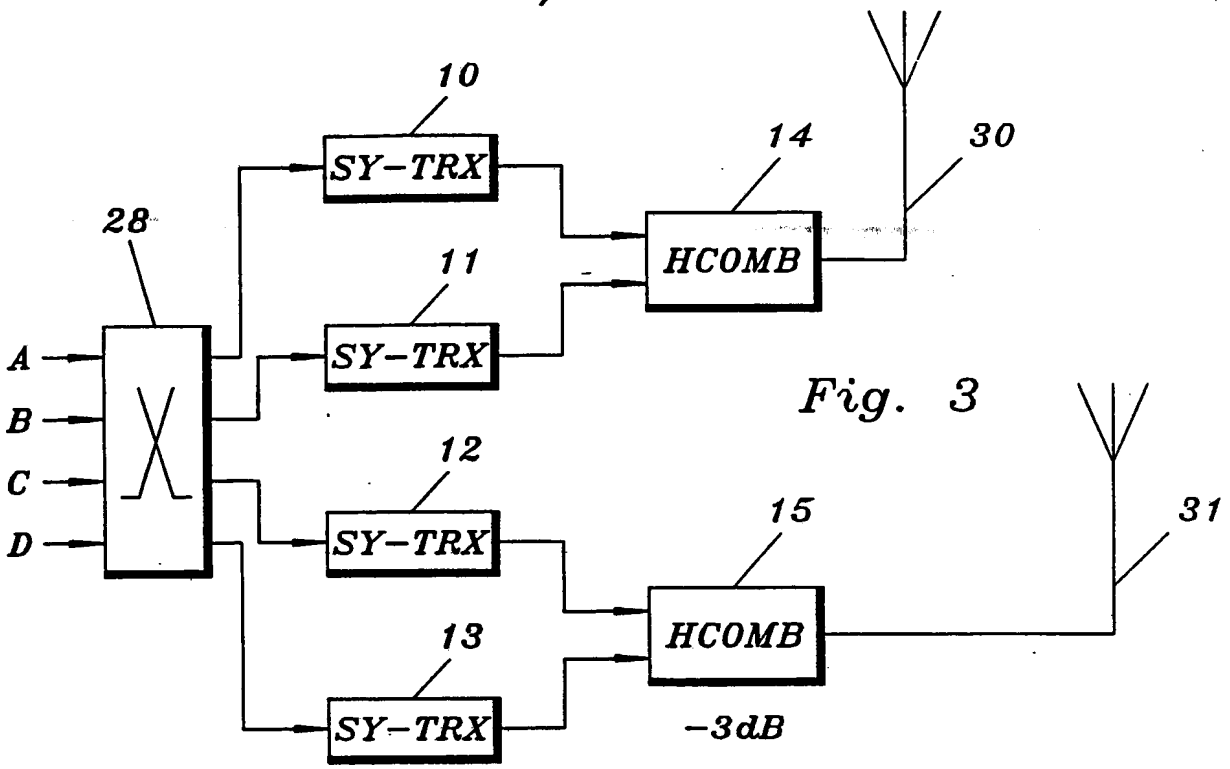

10
SY-TRX
14
30
28
HCOMB
11
SY-TRX
A
B
C
D
12
SY-TRX
15
31
HCOMB
13
SY-TRX
-3dB

Fig. 3

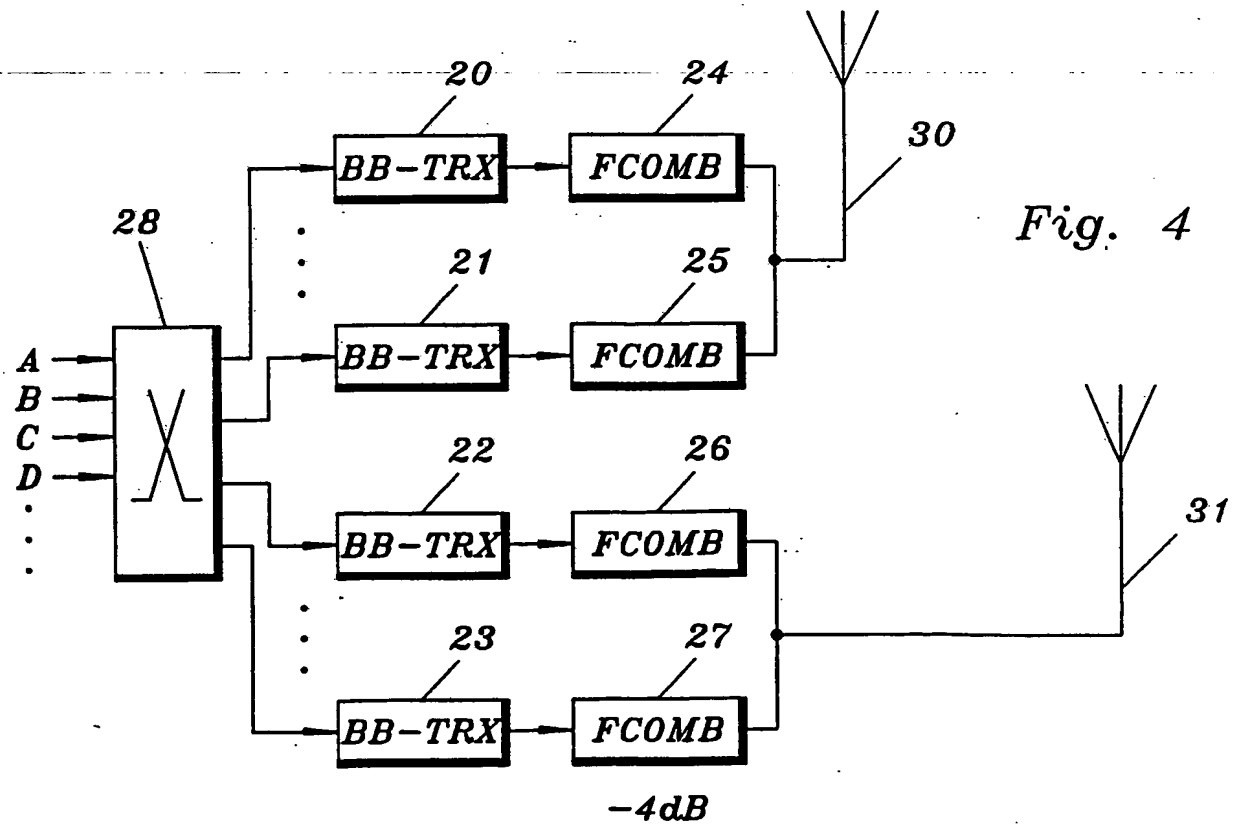

20
24
30
BB-TRX
FCOMB
28
21
25
BB-TRX
FCOMB
A
B
C
D
22
26
31
BB-TRX
FCOMB
23
27
BB-TRX
FCOMB
-4dB

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 93/00238

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: H04B 7/26, H04Q 7/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: H04B, H04J, H01Q, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG: 125, 340, 350, 351

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP, A2, 0439939 (AMERICAN TELEPHONE AND TELEGRAPH COMPANY), 7 August 1991 (07.08.91), column 2, line 34 - column 3, line 1 --	1
A	WO, A1, 9016122 (SOCIETA ITALIANA TELECOMUNICAZIONI S.P.A.), 27 December 1990 (27.12.90), page 4, line 12 - line 23 --	1
A	GB, A, 2242807 (ROKE MANOR RESEARCH LIMITED), 9 October 1991 (09.10.91), abstract --	1

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 June 1993	29 -06- 1993
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Margareta Nylander Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 93/00238

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4545059 (R.J. SPINKS, JR. ET AL), 1 October 1985 (01.10.85), column 2, line 4 - line 24	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/05/93

International application No.
PCT/SE 93/00238

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0439939	07/08/91	JP-A- 4347937	03/12/92
		US-A- 5175878	29/12/92
WO-A1- 9016122	27/12/90	EP-A- 0392987	17/10/90
GB-A- 2242807	09/10/91	NONE	
US-A- 4545059	01/10/85	NONE	